AMENDMENTS TO THE DRAWINGS

The attached sheets of drawings include replacement drawings for FIGS. 1-19.

Attachment: Replacement sheets

REMARKS

Claims 90 and 93-141 are pending in this application. Claims 90, 108, 130 and 138-141 have been amended. No new matter has been introduced.

As requested in the November 14, 2005 Office Action, Applicants resubmit a copy of the Information Disclosure Statement filed on January 4, 2005, together with a copy of a postcard stamped by the PTO and indicating the January 4, 2005 filing date. Consideration of the information submitted with the January 4, 2005 Information Disclosure Statement is respectfully requested.

Replacement sheets for FIGS. 1-19 are submitted for the Examiner's approval. The replacement sheets label reference 136 of FIG. 1 as "130."

The drawings stand objected to under 37 CFR 1.83(a) for failing to show "every feature of the invention specified in the claims." (Office Action at 2). Specifically, the Office Action asserts that various claim terms and expressions such as the limitation "direct contact between said first doped region and said charge storage capacitor" of claim 90, for example, are not illustrated in the drawings. Applicants submit that the drawings illustrate all claim limitations. For example, the limitation "direct contact between said first doped region and said charge storage capacitor" of claim 90 is illustrated in FIG. 12 (electrode of capacitor 299 directly connected to photodiode region 125 through contact 246), and not in FIG. 2, as the Office Action asserts. Similarly, the limitation "storage capacitor is connected directly to said floating diffusion region" of claim 122 is illustrated in FIG. 14, for example (electrode of storage capacitor 399b directly connected to floating diffusion region 130), and not in FIG. 10, as the Office Action asserts.

Applicants also submit that FIG. 10 illustrates only one embodiment of the claimed invention. Additional embodiments directed to capacitor electrodes directly connected to various elements such as transistor gates or doped regions (for example, floating diffusion region or charge collection region) are illustrated separately in FIGS. 11, 14, 15, 16, 17 and 18. In view of the above, Applicants submit that the drawings illustrate all claim limitations. For at least these reasons, withdrawal of the drawing objections is respectfully requested.

Claims 138-141 stand rejected under 35 U.S.C. § 112, second paragraph, as being "indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention." (Office Action at 5) Specifically, the Office Action asserts that the limitation "said photodiode" of claims 138-141 lacks antecedent basis. (Office Action at 5). These claims have been amended to recite the limitation "said photosensor" and to correct, therefore, any perceived indefiniteness. Applicants submit that all pending claims are now in full compliance with 35 U.S.C. § 112.

Claims 90 and 93-141[1] stand rejected under 35 U.S.C. §102(b) as being anticipated by Rhodes (U.S. Patent No. 6,204,524) ("Rhodes"). This rejection is respectfully traversed.

The claimed invention relates to a method of forming a CMOS imager with improved charge storage. As such, amended independent claim 90 recites a "method of forming a CMOS imager" by *inter alia* "providing a semiconductor substrate having a doped layer of a first conductivity type" and "forming a first doped region of a second

[1] Applicants note that claims 91 and 92 have been canceled in the Amendment dated September 29, 2004. Accordingly, only claims 90 and 93-141 (and not 90-141, as the Office Action asserts) could be rejected under 35 U.S.C. §102(b) as being anticipated by Rhodes (U.S. Patent No. 6,204,524).

conductivity type in said doped layer, said first doped region being adjacent a field oxide region." Amended independent claim 90 also recites "forming a charge storage capacitor such that the entire extent of said charge storage capacitor overlies exclusively said field oxide region" and "forming a direct contact between said first doped region and said charge storage capacitor."

Amended independent claim 108 recites a "method of forming a CMOS imager" by *inter alia* "providing a semiconductor substrate having a doped layer of a first conductivity type," "forming a field oxide region within said semiconductor substrate" and "forming a first conductive layer over said field oxide region and said substrate." Amended independent claim 108 also recites "forming an insulating layer over said first conductive layer," "forming a second conductive layer over said insulating layer" and "patterning said first conductive layer, said insulating layer and said second conductive layer to form a storage capacitor and an electrical element of said CMOS imager, wherein the entire extent of said storage capacitor is formed wholly over said field oxide region."

Independent claim 122 recites a "method of forming an imager" by *inter alia* " forming a photosensor including a charge collection region," "forming a floating diffusion region for receiving charge from said charge collection region" and "forming a charge storage capacitor . . . so that one electrode of said storage capacitor is connected directly to said floating diffusion region by an electrical contact."

Amended independent claim 130 recites a "method of forming an imager" by *inter alia* "forming a field oxide region in said semiconductor substrate," "forming a photodiode in said doped layer" and "forming a charge storage capacitor such that the entire extent of said charge storage capacitor overlies exclusively said field oxide

region." Amended independent claim 130 also recites "connecting an electrode of a charge storage capacitor directly to said photodiode by an electrical contact."

Independent claim 137 recites a "method of forming an imager" by *inter alia* "forming a photosensor including a charge collection region," "forming a floating diffusion region for receiving charge from said charge collection region" and "connecting an electrode of a first charge storage capacitor to said floating diffusion region by a first electrical contact." Independent claim 137 further recites "connecting an electrode of a second charge storage capacitor to said charge collection region by a second electrical contact."

Rhodes relates to a CMOS imager that "provides improved charge storage by fabricating a storage capacitor in parallel with the photocollection area of the imager." (Abstract). According to Rhodes, "[t]he storage capacitor may be a flat plate capacitor formed over the pixel, a stacked capacitor or a trench imager formed in the photosensor." (Abstract).

Rhodes fails to disclose all limitations of claims 90 and 93-141. Rhodes does not disclose, teach or suggest "forming a charge storage capacitor such that *the entire extent of said charge storage capacitor overlies exclusively said field oxide region*" and "forming a *direct* contact between said first doped region and said charge storage capacitor," as amended independent claim 90 recites (emphasis added). Rhodes is also silent about "patterning said first conductive layer, said insulating layer and said second conductive layer to form a storage capacitor and an electrical element of said CMOS imager, wherein *the entire extent of said storage capacitor is formed wholly over said field oxide region,*" as amended independent claim 108 recites (emphasis added).

Applicants submit that capacitor 162 of Rhodes simply does not completely lie over field oxide region 115 so that "the entire extent" of it is "exclusively" or "wholly" located over the field oxide region 115. As described and illustrated in all figures of Rhodes, the trench and planar capacitor structures of Rhodes are all formed overlying the active area of the pixel sensor cell, and not such that "the entire extent of said charge storage capacitor overlies exclusively said field oxide region" (claim 90) or "is formed wholly over said field oxide region" (claim 108). Applicants also note that the Abstract of Rhodes clearly specifies that "[t]he storage capacitor may be a flat plate capacitor *formed over the pixel*, a stacked capacitor or a trench imager formed in the photosensor" (emphasis added), and not a capacitor the entire extent of which "overlies exclusively said field oxide region" or "is formed wholly over said field oxide region," as in the claimed invention. Applicants also note that Figure 5 of Rhodes clearly shows parts of electrodes 156 and 160 of the capacitor 162 formed over the doped region 155 and the photogate 102 of the transistor 125 of Rhodes. Thus, storage capacitor 162 of Rhodes is not illustrated in Figure 5 as "overl[ying] exclusively said field oxide region" or "formed wholly over said field oxide region," as in the claimed invention.

Rhodes also does not disclose, teach or suggest "forming a floating diffusion region for receiving charge from said charge collection region" and "forming a charge storage capacitor . . . so that one electrode of said storage capacitor is connected directly to said floating diffusion region by an electrical contact," as independent claim 122 recites. In Rhodes, storage capacitor 162, which would arguably correspond to the "charge storage capacitor" of the claimed invention, is connected to a fifth doped region 155 ("which is formed adjacent to the photogate 102") and not to the floating diffusion region 130. In addition, no electrode of the storage capacitor 162 of Rhodes is connected directly to a floating diffusion region "by an electrical contact," as in the claimed invention.

Rhodes is also silent about "forming a photodiode in [a] doped layer," "forming a charge storage capacitor such that the entire extent of said charge storage capacitor overlies exclusively said field oxide region" and "connecting an electrode of a charge storage capacitor directly to said photodiode by an electrical contact," as amended independent claim 130 recites. As described and illustrated in all figures of Rhodes, the trench and planar capacitor structures of Rhodes are all formed overlying the active area of the pixel sensor cell, and not such that "the entire extent of said charge storage capacitor overlies exclusively said field oxide region" (claim 130). Applicants also note that Figure 5 of Rhodes clearly shows parts of electrodes 156 and 160 of the capacitor 162 formed over the doped region 155 and the photogate 102 of the transistor 125 of Rhodes. Thus, storage capacitor 162 of Rhodes is not illustrated in Figure 5 as "overl[ying] exclusively said field oxide region," as in the claimed invention.

Rhodes is also silent about "connecting an electrode of a first charge storage capacitor to [a] floating diffusion region by a first electrical contact," much less "connecting an electrode of a second charge storage capacitor to said charge collection region by a second electrical contact," as independent claim 137 recites. As noted above, Rhodes does not disclose, teach or suggest the step of connecting an electrode of a storage capacitor to a "floating diffusion region by a first electrical contact," as in the claimed invention. Rhodes is also silent about a "first charge storage capacitor" and a "second charge storage capacitor," much less about "connecting an electrode of a second charge storage capacitor to [a] charge collection region by a second electrical contact," as independent claim 137 recites.

For at least these reasons, Rhodes fails to anticipate the subject matter of claims 90 and 93-141, and withdrawal of the rejection of these claims is respectfully requested.

Claims 130-136 stand rejected under 35 U.S.C. §102(b) as being anticipated by Han et al. (U.S. Patent Pub. No. 2001/006238) ("Han"). This rejection is respectfully traversed.

Han relates to an image sensor that "includes a plurality of unit pixels for sensing a light beam to generate an image data." (Abstract). Han teaches that each of the unit pixels further includes "a photoelectric element for sensing a light beam incident thereto and generating photoelectric charges, a transistor including a gate dielectric formed adjacent to the photoelectric element and a gate electrode formed on top of the gate dielectric and a capacitor structure." (Abstract). According to Han, the capacitor includes "an insulating film formed on a portion of the photoelectric element and a bottom electrode, wherein the insulating film and the gate dielectric are made of a same material and the bottom electrode and the gate electrode are made of a same material." (Abstract).

As noted above, amended independent claim 130 recites a "method of forming an imager" by *inter alia* "forming a field oxide region in said semiconductor substrate," "forming a photodiode in said doped layer" and "forming a charge storage capacitor such that the entire extent of said charge storage capacitor overlies exclusively said field oxide region." Amended independent claim 130 also recites "connecting an electrode of a charge storage capacitor directly to said photodiode by an electrical contact."

Han fails to anticipate the subject matter of claims 130-136. Han does not disclose, teach or suggest all limitations of independent claim 130. Han fails to disclose, teach or suggest "forming a charge storage capacitor such that the entire extent of said charge storage capacitor overlies exclusively said field oxide region," as claim 130 recites. In Han, capacitor 230 is formed over both the active area and the isolation

region 208, and not "such that the *entire extent* of said charge storage capacitor overlies *exclusively* said field oxide region," as in the claimed invention (emphasis added). For at least these reasons, Han fails to anticipate the subject matter of claims 130-136 and withdrawal of the rejection of these claims is respectfully requested.

Claims 95-103, 108-121 and 130-136 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Rhodes in view of Han. This rejection is respectfully traversed.

The subject matter of claims 95-103, 108-121 and 130-136 would not have been obvious over Rhodes in view of Han. Specifically, the Office Action fails to establish a *prima facie* case of obviousness. Courts have generally recognized that a showing of a *prima facie* case of obviousness necessitates three requirements: (i) some suggestion or motivation, either in the references themselves or in the knowledge of a person of ordinary skill in the art, to modify the reference or combine the reference teachings; (ii) a reasonable expectation of success; and (iii) the prior art references must teach or suggest all claim limitations. See e.g., In re Dembiczak, 175 F.3d 994, 50 (Fed. Cir. 1999); In re Rouffet, 149 F.3d 1350, 1355 (Fed. Cir. 1998); Pro-Mold & Tool Co. v. Great Lakes Plastics, Inc., 75 F.3d 1568, 1573 (Fed. Cir. 1996).

In the present case, Rhodes and Han, whether considered alone or in combination, fail to disclose, teach or suggest all limitations of independent claims 90, 108 and 130. Rhodes does not disclose, teach or suggest "forming a charge storage capacitor such that *the entire extent of said charge storage capacitor overlies exclusively said field oxide region*" and "forming a *direct* contact between said first doped region and said charge storage capacitor," as amended independent claim 90 recites (emphasis added). Rhodes is also silent about "patterning said first conductive layer, said insulating layer and said second conductive layer to form a storage capacitor and an electrical element

of said CMOS imager, wherein *the entire extent of said storage capacitor is formed wholly over and in contact with said field oxide region,*" as amended independent claim 108 recites (emphasis added).

Applicants resubmit that, as described and illustrated in all figures of Rhodes, the trench and planar capacitor structures of Rhodes are all formed overlying the active area of the pixel sensor cell, and not such that "the entire extent of said charge storage capacitor overlies exclusively said field oxide region" (claim 90) or "is formed wholly over said field oxide region" (claim 108). Applicants also note that the Abstract of Rhodes clearly specifies that "[t]he storage capacitor may be a flat plate capacitor *formed over the pixel,* a stacked capacitor or a trench imager formed in the photosensor" (emphasis added), and not a capacitor the entire extent of which "overlies exclusively said field oxide region" or "is formed wholly over said field oxide region," as in the claimed invention. Applicants also note that Figure 5 of Rhodes clearly shows parts of electrodes 156 and 160 of the capacitor 162 formed over the doped region 155 and the photogate 102 of the transistor 125 of Rhodes. Thus, storage capacitor 162 of Rhodes is not illustrated in Figure 5 as "overl[ying] exclusively said field oxide region" or "formed wholly over said field oxide region," as in the claimed invention.

Similarly, Han is silent about a "method of forming a CMOS imager" by "providing a semiconductor substrate having a doped layer of a first conductivity type," "forming a first doped region of a second conductivity type in said doped layer, said first doped region being adjacent a field oxide region" and "forming a charge storage capacitor such that the entire extent of said charge storage capacitor overlies exclusively said field oxide region," as amended independent claim 90 recites. Han also fails to teach or suggest a "method of forming a CMOS imager" by "patterning said first conductive layer, said insulating layer and said second conductive layer to form a storage capacitor and an electrical element of said CMOS imager, wherein the

entire extent of said storage capacitor is formed wholly over and in contact with said field oxide region," as amended independent claim 108 recites. In Han, capacitor 230 is formed over both the active area and the isolation region 208, and not "such that the *entire extent* of said charge storage capacitor overlies *exclusively* said field oxide region," or "*wholly over* said field oxide region," as in the claimed invention (emphasis added).

Rhodes and Han, alone or in combination, also fail to disclose all limitations of amended independent claim 130. Neither Rhodes nor Han discloses, teaches or suggests "forming a field oxide region in said semiconductor substrate," "forming a photodiode in said doped layer" and "forming a charge storage capacitor such that the entire extent of said charge storage capacitor overlies exclusively said field oxide region," as amended independent claim 130 recites.

Applicants also submit that a person of ordinary skill in the art would not have been motivated to combine Rhodes with Han to arrive at the claimed invention. On one hand, the crux of Rhodes is the formation of a CMOS imager which comprises a storage capacitor formed in parallel with a photocollection area of the imager, to improve the signal-to-noise ratio and the dynamic range. Rhodes clearly emphasizes that "the storage capacitor [is] formed in parallel with a light sensitive node of the CMOS imager." (Col. 1, lines 7-10). On the other hand, the crux of Han is a method of manufacturing a capacitor so that the insulating film of the capacitor and the gate dielectric of an adjacent transistor are made of a same material, while the bottom electrode of the capacitor and the gate electrode are also made of a same material Accordingly, a person of ordinary skill in the art would not have been motivated to combine Rhodes, which teaches formation of a capacitor in parallel with a sensitive node of the CMOS imager and independent of the formation of adjacent transistor structures, with Han, which teaches methods of forming a capacitor concurrently with

the formation of the adjacent transistor structures, so that elements of the capacitor are formed of same material as that of the transistor elements.

For at least these reasons, Applicants submit that the Office Action fails to establish a *prima facie* case of obviousness, and withdrawal of the rejection of claims 95-103, 108-121 and 130-136 is respectfully requested.

Claims 137-141 stand rejected under 35 U.S.C. §103 as being unpatentable over Rhodes in view of Lauxtermann et al. (U.S. Patent Pub. No. 2001/0015831) ("Lauxtermann"). This rejection is respectfully traversed.

As noted above, independent claim 137 recites a "method of forming an imager" by *inter alia* "forming a photosensor including a charge collection region," "forming a floating diffusion region for receiving charge from said charge collection region" and "connecting an electrode of a first charge storage capacitor to said floating diffusion region by a first electrical contact." Independent claim 137 further recites "connecting an electrode of a second charge storage capacitor to said charge collection region by a second electrical contact."

Lauxtermann relates to "a method for operating a CMOS image sensor including a matrix of pixels (50) arranged in a plurality of lines and columns, each of said pixels including a photosensor element (PD) accumulating charge carriers in proportion to the illumination thereof and storage means (C1,55) able to be coupled to said photosensor element (PD) at a determined instant in order to generate a sampled signal representative of said charge carriers accumulated by the photosensor, the storage means (C1, 55) being intended to assure storage for the purpose of reading said sampling signal." (Abstract). According to Lauxtermann, "when said sampled signal, stored across said storage means is read, the photosensor element is held at a voltage

such that any charge carrier generated by the latter is drained and thus does not disturb the sampled signal stored on the storage means." (Abstract).

The subject matter of claims 137-141 would not have been obvious over Rhodes in view of Lauxtermann. As noted above, Rhodes fails to disclose, teach or suggest all limitations of independent claim 137. Rhodes is silent about "connecting an electrode of a first charge storage capacitor to [a] floating diffusion region by a first electrical contact," much less "connecting an electrode of a second charge storage capacitor to said charge collection region by a second electrical contact," as independent claim 137 recites. Rhodes also does not disclose, teach or suggest the step of connecting an electrode of a storage capacitor to a "floating diffusion region by a first electrical contact," as in the claimed invention. Rhodes is also silent about a "first charge storage capacitor" and a "second charge storage capacitor," much less about "connecting an electrode of a second charge storage capacitor to [a] charge collection region by a second electrical contact," as independent claim 137 recites.

Similarly, Lauxtermann is silent about any of the limitations of claim 137. Lauxtermann relates to a method of maintaining constant the sampled charge stored in memory node 55 during the read process (¶[0010]), and not to methods of forming CMOS imagers, much less to methods of forming CMOS imagers by the specific steps of the claimed invention. Accordingly, and for at least these reasons, the Office Action fails to establish a *prima facie* case of obviousness. Withdrawal of the rejection of claims 137-141 is also respectfully requested.

Allowance of claims 90 and 93-141 is solicited.

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Respectfully submitted,

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